

PRELIMINARY DATA SUMMARY

November 1988

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

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CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

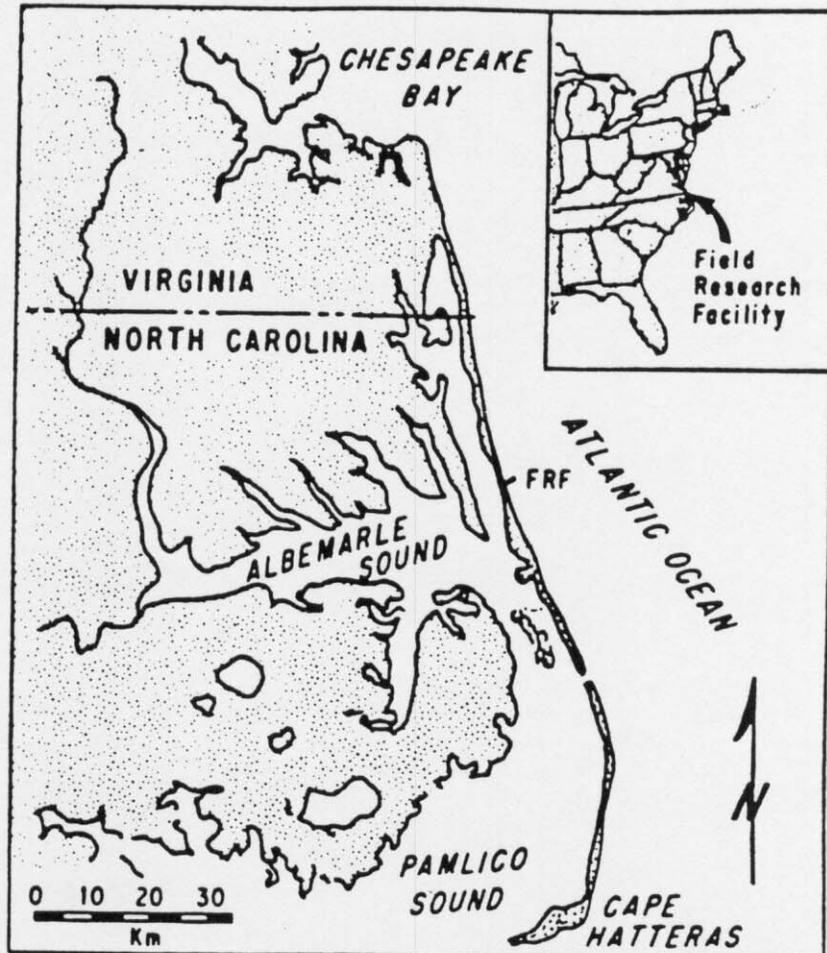


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

NOV 1988

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3				
616	Barometric Pressure		Gage Status	*****																														
			Data Collected	*****																														
			Analog Record	*****																														
604	Precipitation		Gage Status	*****																														
			Data Collected	*****																														
624	Air Temperature		Gage Status	*****																														
			Data Collected	/ - - / *****																														
632	Anemometer on Laboratory Building Elevation 19 m (NGVD)		Gage Status	*****																														
			Data Collected	*****																														
			Analog Record	*****																														
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / / *****																														
625	Baylor staff at station 19+00 on FRF pier	see Figure 7	Gage Status	***** / - - - - -																														
			Data Collected	***** / ** / ***** / - - - - -																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																														
			Data Collected	***** / *****																														
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	/ - - - / *****																														
			Data Collected	/ - - - / ***** / / - / *****																														
679	Current meter 500 m south of FRF pier (0.5 km offshore)	see Figure 7	Gage Status	*****																														
			Data Collected	*****																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																														
			Data Collected	*****																														
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	*****																														

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

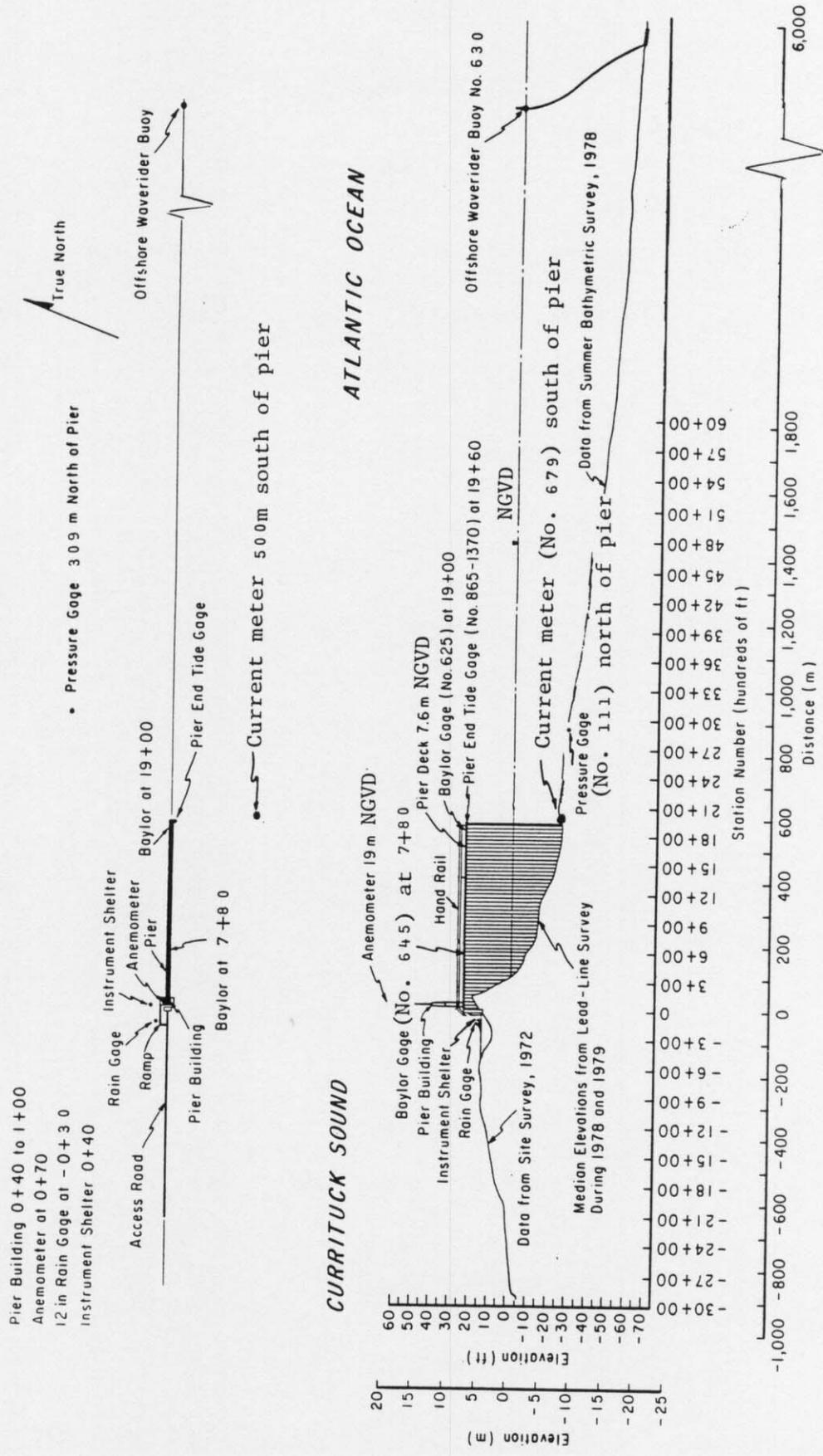


Figure 2. Instrument locations at FRF

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Nov 1988						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	8	44	15.6	1014.8	0
	700	3	93		1008.4	4
	1300	8	346		1003.7	26
	1900	7	311		1004.3	0
2	100	6	264		1005.0	0
	700	7	257		1005.7	0
	1300	0			1006.4	0
	1900	6	266		1010.8	0
3	100	6	276	Gage Inoperative	1013.1	0
	700	5	286		1016.2	0
	1300	4	230		1015.9	0
	1900	3	182		1015.9	0
4	100	3	197		1015.5	2
	700	3	188		1015.5	0
	1300	3	137		1012.1	0
	1900	3	142	16.8	1008.4	0
5	100	6	103	16.5	1003.3	0
	700	5	166	18.5	999.6	0
	1300	6	180	18.9	994.5	3
	1900	8	223	17.2	996.2	0
6	100	7	198	15.2	1002.6	0
	700	4	213	14.2	1004.3	0
	1300	5	224	18.2	1003.3	0
	1900	7	196	16.2	1004.7	0
7	100	8	235	13.2	1008.1	0
	700	5	220	11.4	1011.4	0
	1300	8	244	15.9	1011.8	0
	1900	2	219	11.9	1014.5	0
8	100	3	212	11.2	1017.2	0
	700	3	217	11.2	1018.2	0
	1300	3	136	19.6	1016.5	0
	1900	6	194	14.9	1016.2	0
9	100	3	220	13.1	1017.9	0
	700	11	14	13.8	1020.9	0
	1300	6	19	14.0	1021.6	0
	1900	5	65	12.8	1022.3	0
10	100	4	76	13.4	1020.9	0
	700	3	127	14.3	1018.2	0
	1300	5	187	21.4	1014.2	0
	1900	7	195	19.4	1011.8	0
11	100	8	235	18.4	1012.1	0
	700	11	2	14.7	1016.9	0
	1300	9	3	14.4	1018.9	0
	1900	11	10	12.9	1021.9	0
12	100	10	12	11.1	1024.7	0
	700	8	44	11.4	1027.0	0
	1300	8	29	12.3	1026.7	0
	1900	9	60	12.8	1025.7	0
13	100	4	44	14.4	1023.3	0
	700	2	178	13.3	1020.3	0
	1300	3	202	20.4	1017.5	0
	1900	5	357	14.8	1018.2	0
14	100	3	313	13.2	1019.2	0
	700	6	60	14.3	1020.6	0
	1300	4	26	16.5	1020.9	0
	1900	2	48	14.2	1020.9	0
15	100	2	3	13.0	1021.3	0
	700	1	349	14.4	1009.1	0
	1300	5	54	16.6	1021.9	0
	1900	5	65	15.1	1021.9	0
16	100	3	123	15.9	1021.3	0
	700	4	135	15.9	1019.9	0
	1300	4	177	22.1	1018.6	0
	1900	6	174	19.6	1017.5	0

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Nov 1988

Day	Hour	Wind Speed	Wind Direction	Temperature	Atm Pressure	Precipitation
		m/sec	deg TN	deg C	mb	mm
17	100	4	181	18.0	1015.9	0
	700	6	192	19.6	1014.2	0
	1300	10	348	13.7	1014.8	73
	1900	4	23	13.0	1019.9	0
18	100	3	311	10.3	1023.0	0
	700	11	14	10.9	1027.0	0
	1300	6	23	11.4	1027.4	0
	1900	5	37	10.7	1027.7	0
19	100	7	42	11.4	1027.0	0
	700	8	53	12.3	1026.7	0
	1300	5	56	14.9	1023.6	0
	1900	3	132	15.0	1022.6	0
20	100	7	158	17.2	1019.2	0
	700	5	181	17.4	1016.2	0
	1300	8	194	22.4	1011.1	4
	1900	13	201	21.0	1005.7	0
21	100	11	248	20.0	1006.7	0
	700	7	295	13.5	1012.8	0
	1300	10	4	13.9	1016.2	0
	1900	12	356	11.7	1021.3	0
22	100	6	340	8.9	1023.6	0
	700	9	31	9.8	1026.0	0
	1300	6	13	10.9	1026.3	0
	1900	7	50	11.1	1024.7	0
23	100	7	17	12.6	1021.9	0
	700	8	35	13.7	1019.6	0
	1300	7	8	14.3	1016.2	0
	1900	12	37	13.1	1013.1	0
24	100	13	14	11.7	1010.8	0
	700	14	356	9.6	1012.1	0
	1300	11	345	8.5	1014.5	0
	1900	5	317	7.0	1016.9	0
25	100	5	304	6.6	1017.5	0
	700	4	297	6.4	1019.2	0
	1300	2	310	12.4	1018.9	0
	1900	3	159	9.8	1018.9	0
26	100	4	225	9.6	1018.6	0
	700	4	222	9.9	1018.6	0
	1300	3	205	17.4	1016.9	0
	1900	5	179	15.4	1017.2	0
27	100	5	182	15.0	1016.2	0
	700	6	182	16.6	1015.2	0
	1300	6	178	20.6	1012.5	0
	1900	6	187	18.6	1011.4	0
28	100	7	185	19.4	1007.0	0
	700	8	190	19.8	1002.6	6
	1300	8	267	12.4	1003.3	0
	1900	9	251	10.3	1012.5	0
29	100	9	278	6.2	1017.9	0
	700	7	299	4.2	1024.3	0
	1300	3	358	9.1	1024.7	0
	1900	3	174	6.4	1025.7	0
30	100	3	159	6.7	1024.0	0
	700	2	175	7.3	1021.9	0
	1300	4	229	12.2	1018.2	0
	1900	3	175	12.2	1015.9	0
		Resultant		Mean	Mean	Total
		1	327	13.9	1016.1	118

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Nov 1988

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 19+00 T,sec	Pressure Hmo,m	Gage T,sec	Farshr Hmo,m	Wvrdr T,sec
1	0100	0.91	5.57	1.22	4.92	1.16	5.02		
	0700	1.01	5.45	1.42	5.22	1.35	5.12		
	1300	1.45	6.09	2.10	6.74	2.07	8.00		
	1900	1.11	7.11	1.63	7.76	1.67	7.11		
2	0100	1.00	6.56	1.24	8.83	1.27	8.26		
	0700	0.78	6.40	0.89	8.53	0.97	8.53		
	1300	0.62	9.14	0.74	9.48	0.73	9.14		
	1900	0.79	13.47	0.83	13.47	0.88	12.80		
3	0100	0.44	12.80	0.59	12.80	0.63	12.80		
	0700	0.57	13.47	0.64	12.80	0.58	12.19		Gage Inoperative
	1300	0.37	12.80	0.60	12.19	0.60	12.80		
	1900	0.37	13.47	0.44	12.19	0.48	11.66		
4	0100	0.30	11.64	0.42	12.19	0.48	12.80		
	0700	0.29	12.19	0.34	11.64	0.42	12.19		
	1300	0.31	11.64	0.40	11.64	0.43	11.64		
	1900	0.72	5.45	0.75	5.82	0.78	5.69		
5	0100	1.07	7.76	1.30	8.26	1.47	7.76		
	0700	0.83	8.26	1.11	7.76	1.14	8.83	1.51	8.53
	1300	1.00	8.26	1.24	8.26	1.32	8.53	1.64	8.83
	1900	0.97	9.48	1.21	9.48	1.30	9.85	1.72	9.85
6	0100	0.84	9.85	0.99	10.24	1.03	9.85	1.37	9.85
	0700	0.58	9.85	0.71	10.24	0.75	10.67	1.02	10.24
	1300	0.59	8.83	0.69	9.48	0.75	8.83	0.93	8.83
	1900	0.58	8.26	0.64	8.83	0.69	8.83	1.00	8.53
7	0100	0.44	8.83	0.44	8.00	0.52	7.76	0.73	7.53
	0700	0.28	8.26	0.35	8.00	0.42	8.26	0.51	7.53
	1300	*		0.34	8.26	0.37	7.76	0.51	8.53
	1900	*		0.36	9.14	0.40	7.76	0.44	8.26
8	0100	*		0.36	9.14	0.35	8.00	0.43	8.00
	0700	*		0.32	8.83	0.34	7.76	0.43	7.76
	1300	*		0.33	8.83	0.34	8.00	0.44	12.19
	1900	0.21	12.19	0.40	12.19	0.40	12.80	0.59	2.98
9	0100	0.14	12.19	0.29	12.19	0.30	12.19	0.39	12.19
	0700	0.54	4.41	0.98	4.66	0.95	4.49	1.20	4.74
	1300	0.50	5.33	0.86	4.92	0.94	5.57	1.06	5.22
	1900	0.37	5.33	0.68	5.12	0.64	5.57	0.76	5.33
10	0100	0.26	5.12	0.53	4.66	0.54	4.57	0.60	4.83
	0700	0.25	8.00	0.47	8.00	0.41	8.26	0.55	7.76
	1300	0.18	11.13	*		0.43	8.26	0.50	7.76
	1900	0.26	8.26	0.43	8.26	0.48	4.06	0.69	3.77
11	0100	0.18	4.27	0.31	8.00	0.37	8.26	0.62	7.53
	0700	0.57	4.27	0.87	4.27	0.90	4.27	1.12	4.20
	1300	0.57	5.57	0.98	5.69	1.12	5.33	1.38	5.45
	1900	0.71	5.82	1.11	5.69	1.29	5.82	1.44	5.69
12	0100	0.59	5.95	1.22	5.82	1.39	5.82	1.67	6.09
	0700	0.73	6.09	1.07	6.09	1.12	6.09	1.29	6.24
	1300	0.55	5.95	0.85	6.09	0.95	6.09	1.03	5.45
	1900	0.64	6.24	1.14	5.22	1.20	6.24	1.32	6.24
13	0100	0.56	5.95	0.93	6.09	1.06	5.82	1.19	5.69
	0700	0.57	6.56	1.15	6.56	1.18	6.56	*	
	1300	0.52	7.11	0.99	7.31	1.19	7.11	1.46	7.31
	1900	0.42	6.09	*		0.94	6.56	1.26	7.11
14	0100	0.29	6.40	0.65	6.40	0.76	6.56	0.93	6.92
	0700	0.33	6.74	0.65	7.11	0.65	6.74	0.87	6.92
	1300	0.31	7.31	0.62	7.11	0.76	7.11	*	
	1900	0.38	6.92	0.80	7.31	0.94	7.31	*	
15	0100	0.33	7.76	0.76	7.11	0.86	7.53	*	
	0700	0.28	7.11	0.83	6.74	0.78	6.92	*	
	1300	0.24	9.14	0.54	7.11	0.65	6.56	*	
	1900	0.28	3.08	0.58	8.53	0.65	6.56	*	
16	0100	0.30	8.00	0.63	7.76	0.72	7.53	*	
	0700	0.33	4.66	0.65	7.53	0.73	7.53	*	
	1300	0.41	5.45	0.79	5.22	0.75	5.02	0.87	5.33
	1900	0.31	5.33	0.58	8.00	0.69	5.82	0.86	5.45

\* Electronic problems

(Continued)

(Sheet 1 of 2)

Table 3: Wave Data

Nov 1988

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 19+00 T,sec	Pressure Hmo,m	Gage T,sec	Farshr Hmo,m	Wvrdr T,sec
17	0100	0.38	5.69	0.64	5.33	0.74	5.69	1.00	5.45
	0700	0.32	5.82	0.52	7.11	0.72	6.40	0.99	5.82
	1300	0.40	6.56	1.08	3.16	0.74	3.46	1.18	4.00
	1900	0.55	5.69	0.74	5.82	0.84	5.57	0.95	5.33
18	0100	0.53	6.24	1.58	6.09	0.82	6.40	0.92	5.45
	0700	0.59	5.82	1.92	5.45	1.42	5.45	1.49	5.82
	1300	0.68	6.40			1.07	6.40	1.17	6.40
	1900	0.62	6.09			0.79	5.69	0.88	5.82
19	0100	0.51	5.45			0.68	4.92	0.83	5.22
	0700	0.52	4.74			0.76	3.88	0.93	3.94
	1300	0.58	4.57			0.93	4.66	1.10	4.83
	1900	0.40	4.49			0.68	4.34	0.81	4.49
20	0100	0.52	5.33			0.80	5.12	1.05	4.92
	0700	0.46	5.69			0.85	5.82	1.07	5.57
	1300	0.55	6.92			0.87	6.24	1.20	6.24
	1900	0.59	7.11			0.95	7.11	1.34	4.92
21	0100	0.37	7.31			0.67	7.53	1.00	8.00
	0700	0.33	4.83			0.56	3.88	0.80	4.34
	1300	0.78	5.33			1.25	5.82	1.46	5.82
	1900	1.02	7.11			1.67	6.40	1.96	6.74
22	0100	0.78	6.24			1.11	5.33	1.29	5.82
	0700	0.93	6.40			1.13	6.40	1.42	5.69
	1300	0.65	6.74			1.09	6.24	1.20	7.76
	1900	0.82	6.92			0.96	6.74	1.10	6.74
23	0100	0.70	5.82			0.81	5.45	0.97	6.24
	0700	0.77	5.02			0.86	3.61	0.98	4.13
	1300	0.77	4.74			0.91	4.49	1.02	4.49
	1900	1.18	5.02			1.56	5.02	1.85	5.22
24	0100	0.88	6.09			1.91	6.09	2.29	5.95
	0700	1.44	6.74			2.19	6.56	2.38	6.56
	1300	0.82	7.31				*	2.05	7.11
	1900	1.06	7.11			1.61	7.53	1.66	7.31
25	0100	0.77	7.31			1.29	8.83	1.33	7.76
	0700	0.89	5.69			1.19	8.53	1.16	9.14
	1300	0.75	7.31			1.16	8.83	1.14	7.31
	1900	0.63	6.74			0.99	9.85	0.97	8.00
26	0100	0.55	9.48			0.85	9.48	0.82	8.83
	0700	0.32	9.14			0.65	9.85	0.58	9.48
	1300	0.21	9.48			0.50	9.14	0.46	9.48
	1900	0.21	10.24			0.48	8.26	0.49	8.00
27	0100	0.19	9.85			0.36	9.14	0.44	9.14
	0700	0.28	3.24			0.43	3.71	0.57	3.37
	1300	0.33	16.00			0.52	15.06	0.77	6.40
	1900	0.34	15.06			0.59	7.11	0.75	6.92
28	0100	0.50	3.56			0.72	3.51	0.99	4.00
	0700	0.47	8.00			0.77	7.76	0.92	8.26
	1300	0.32	8.26			0.67	8.83	0.82	8.53
	1900	0.72	5.57			0.85	5.57	1.04	5.69
29	0100	0.50	4.57			0.66	3.56	1.06	4.57
	0700	0.59	4.92			0.76	4.74	1.03	5.12
	1300	0.58	6.24			0.77	6.24	0.87	5.82
	1900	0.54	5.02			0.63	5.33	0.69	5.02
30	0100	0.27	15.06			0.47	8.53	0.49	7.76
	0700	0.22	13.47			0.49	7.76	0.48	7.53
	1300	0.19	13.47			0.40	13.47	0.39	13.47
	1900	0.15	13.47			0.36	13.47	0.33	12.80
	Mean	0.55	7.51	0.80	7.86	0.85	7.36	1.01	6.76
	Std dev	0.27	2.80	0.39	2.39	0.37	2.49	0.42	2.05

\* Electronic problems

(Sheet 2 of 2)

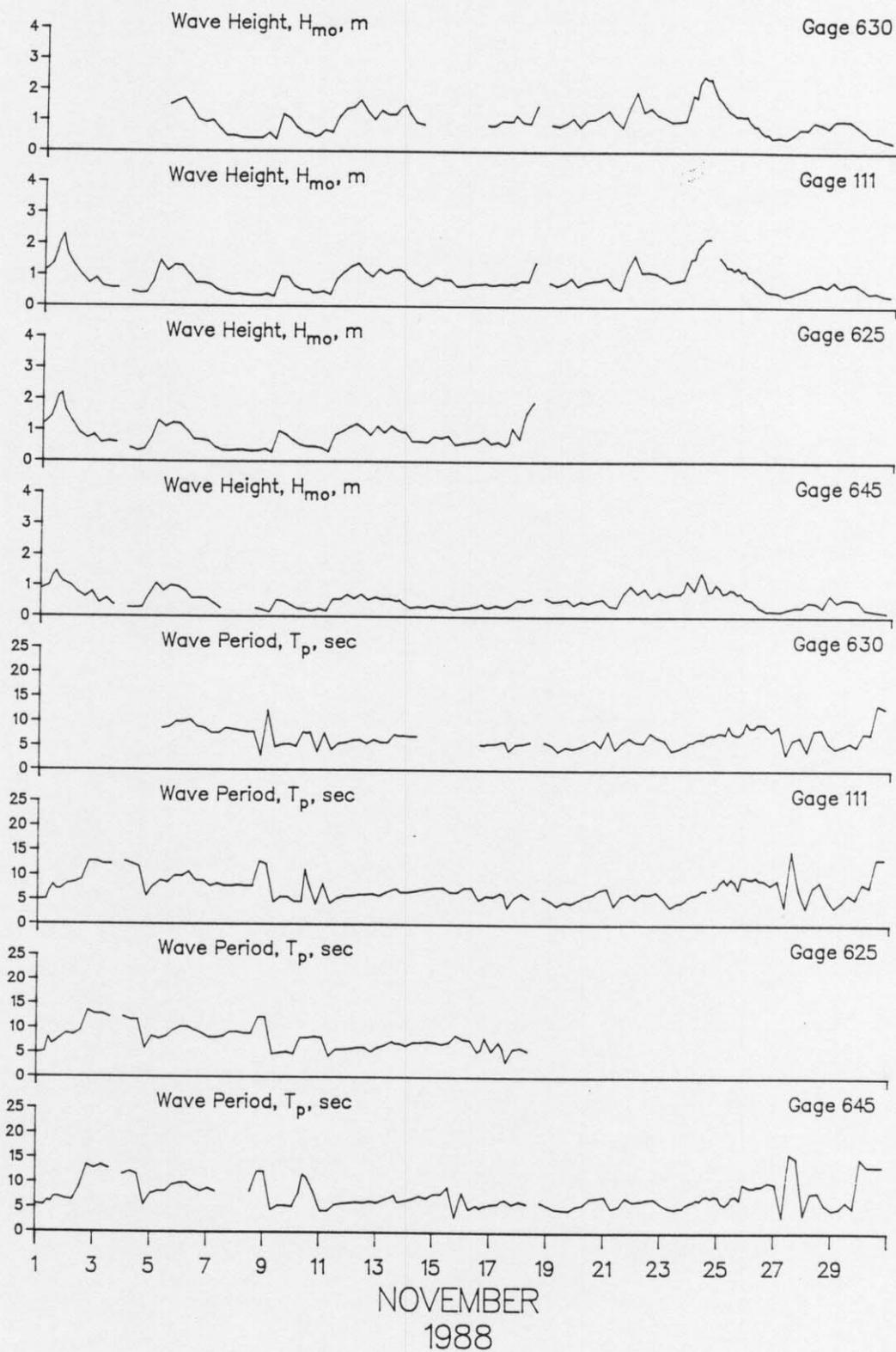


Figure 3. Time history of wave heights and periods

#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
Nov 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
1	0100	Along Cross Result									2 3 4	S off 104
1	0700	Along Cross Result	14 0 14	S  160	165	27 12 29	N off 4	25 North	N		2 3 4	S off 104
1	1300	Along Cross Result									27 5 27	S off 150
1	1900	Along Cross Result									27 4 27	S off 152
2	0100	Along Cross Result									10 0 10	S  160
2	0700	Along Cross Result	0 12 12	 off 70	152	29 17 34	S off 129	0 North			3 0 3	N  340
2	1300	Along Cross Result									14 5 15	N on 320
2	1900	Along Cross Result									2 0 2	N  340
3	0100	Along Cross Result									19 6 20	N on 322
3	0700	Along Cross Result	23 3 23	N off 349	152	0 0 0		3 South	N		19 4 19	N on 328
3	1300	Along Cross Result									20 5 21	N on 326
3	1900	Along Cross Result									13 4 14	N on 323
4	0100	Along Cross Result									15 3 15	N on 329
4	0700	Along Cross Result	24 0 24	N  340	152	47 0 47	N  340	18 South	N		10 4 11	N on 318
4	1300	Along Cross Result									13 2 13	N on 331
4	1900	Along Cross Result									4 1 4	N on 326
5	0100	Along Cross Result									6 4 7	N on 306
5	0700	Along Cross Result	14 1 14	N off 346	165	51 0 51	N  340	0 South			8 0 8	S  160
5	1300	Along Cross Result									26 4 26	N on 331
5	1900	Along Cross Result									10 6 12	N on 309

KEY = All speeds in CM/SEC  
N = Northward, Shore parallel  
S = Southward, Shore parallel  
on = onshore off = offshore

Table 4: Current Data (Continued)  
Nov 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed Dir		Location	Dye 12m offshore (surface)		Speed	Dir
			Speed	Dir		Speed	Dir		Speed	Dir		
6	0100	Along Cross Result									16	N
											4	on
											16	326
6	0700	Along Cross Result	21	N	165	76	N	South	25	S	5	N
			12	off		11	off				4	on
			24	9		77	349				6	301
6	1300	Along Cross Result									15	N
											5	on
											16	322
6	1900	Along Cross Result									18	N
											3	on
											18	331
7	0100	Along Cross Result									17	N
											6	on
											18	321
7	0700	Along Cross Result	23	N	152	36	N	South	12	N	11	N
			2	off		11	off				2	on
			24	346		37	357				11	330
7	1300	Along Cross Result									13	N
											5	on
											14	319
7	1900	Along Cross Result									6	N
											1	on
											6	331
8	0100	Along Cross Result									6	N
											3	on
											7	313
8	0700	Along Cross Result	16	N	152	23	N	South	25	N	5	N
			5	off		4	off				1	on
			17	357		24	349				5	329
8	1300	Along Cross Result									6	N
											3	on
											7	313
8	1900	Along Cross Result									10	N
											2	on
											10	329
9	0100	Along Cross Result									5	N
											4	on
											6	301
9	0700	Along Cross Result	44	S	152	51	S	North	98	S	13	S
			13	on		5	on				3	off
			45	177		51	166				13	147
9	1300	Along Cross Result									16	S
											4	off
											16	146
9	1900	Along Cross Result									13	S
											3	off
											13	147
10	0100	Along Cross Result									10	S
											3	off
											10	143
10	0700	Along Cross Result	16	N	152	15	N	South	24	N	1	S
			0			5	off				2	off
			16	340		16	357				2	97
10	1300	Along Cross Result									1	N
											2	on
											2	277
10	1900	Along Cross Result									13	N
											2	on
											13	331

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Table 4: Current Data (Continued)  
Nov 1988

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
		Alongshore Cross-shore Resultant		Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)		Speed	Dir
		Speed	Dir						Location	Speed		
11	0100-Along Cross Result									9	N	
										3	on	
										9	322	
11	0700-Along Cross Result	55	S		47	S		124	S	10	S	
		11	on	165	12	on	North			2	off	
		57	171		48	174				10	149	
11	1300-Along Cross Result									22	S	
										4	off	
										22	150	
11	1900-Along Cross Result									21	S	
										3	off	
										21	152	
12	0100-Along Cross Result									24	S	
										5	off	
										25	148	
12	0700-Along Cross Result	18	S		25	S		85	S	13	S	
		5	on	165	4	off	North			6	off	
		19	177		26	151				14	135	
12	1300-Along Cross Result									14	S	
										4	off	
										15	144	
12	1900-Along Cross Result									11	S	
										3	off	
										11	145	
13	0100-Along Cross Result									12	S	
										4	off	
										13	142	
13	0700-Along Cross Result	3	N		87	N		40	N	4	S	
		0		152	13	off	South			2	off	
		3	340		88	349				4	133	
13	1300-Along Cross Result									1	S	
										2	off	
										2	97	
13	1900-Along Cross Result									0		
										0		
										0		
14	0100-Along Cross Result									7	S	
										8	off	
										11	111	
14	0700-Along Cross Result	5	S		30	N		14	S	1	S	
		3	on	152	0		North			5	off	
		6	187		30	340				5	81	
14	1300-Along Cross Result									6	S	
										5	off	
										8	120	
14	1900-Along Cross Result									4	S	
										1	on	
										4	174	
15	0100-Along Cross Result									4	S	
										0		
										4	160	
15	0700-Along Cross Result	22	N		32	N		28	N	8	N	
		0		152	10	on	South			1	on	
		22	340		33	323				8	333	
15	1300-Along Cross Result									6	N	
										0		
										6	340	
15	1900-Along Cross Result									4	N	
										0		
										4	340	

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Table 4: Current Data (Continued)  
Nov 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
			Dye at (579 m) (surface)		Dye at Distance from Baseline (m)	Speed Dir		Dye 12m offshore (surface)			Speed	Dir
			Speed	Dir	(m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
16	0100	Along Cross Result									4 0 4	S  160
16	0700	Along Cross Result	15 0 15	N  340	165	55 3 55	N off 343	South	28 N		1 0 1	N  340
16	1300	Along Cross Result									5 2 5	N on 318
16	1900	Along Cross Result									8 2 8	N on 326
17	0100	Along Cross Result									5 2 5	N on 318
17	0700	Along Cross Result	47 12 48	N off 354	165	68 20 71	N on 323	South	91 N		12 2 12	N on 331
17	1300	Along Cross Result									3 1 3	N off 358
17	1900	Along Cross Result									12 4 13	S off 142
18	0100	Along Cross Result									9 2 9	S off 147
18	0700	Along Cross Result	27 5 27	N off 351	152	68 24 72	S on 179	North	74 S		20 5 21	S off 146
18	1300	Along Cross Result									14 3 14	S off 148
18	1900	Along Cross Result									12 3 12	S off 146
19	0100	Along Cross Result									6 2 6	S off 142
19	0700	Along Cross Result	12 3 12	S on 177	165	68 0 68	N  340	South	14 N		13 4 14	S off 143
19	1300	Along Cross Result									4 2 4	S off 133
19	1900	Along Cross Result									7 2 7	S off 144
20	0100	Along Cross Result									6 0 6	N  340
20	0700	Along Cross Result	41 10 42	N off 354	165	87 0 87	N  340	South	84 N		13 0 13	N  340
20	1300	Along Cross Result									23 3 23	N on 333
20	1900	Along Cross Result									22 2 22	N on 335

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Table 4: Current Data (Continued)  
Nov 1988

Day	Time	Pier Measurements					Beach Measurements			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)		Dye 12m offshore (surface) (500m Updrift)			Speed	Dir	
		Speed	Dir	Speed	Dir	Location	Speed	Dir			
21	0100	Along								14	N
		Cross								5	on
		Result								15	320
21	0700	Along	29	S		13	S			7	S
		Cross	4	off	152	2	off	North	10	1	off
		Result	29	151		13	151			7	152
21	1300	Along								16	S
		Cross								3	off
		Result								16	149
21	1900	Along								26	S
		Cross								5	off
		Result								26	149
22	0100	Along								18	S
		Cross								3	off
		Result								18	151
22	0700	Along	29	S		47	S			18	S
		Cross	9	on	165	7	on	North	61	4	off
		Result	30	177		47	169			18	147
22	1300	Along								6	S
		Cross								3	off
		Result								7	133
22	1900	Along								12	S
		Cross								3	off
		Result								12	146
23	0100	Along								8	S
		Cross								2	off
		Result								8	146
23	0700	Along	38	S		18	S			16	S
		Cross	0		152	6	off	North	62	3	off
		Result	38	160		19	143			16	149
23	1300	Along								16	S
		Cross								4	off
		Result								16	146
23	1900	Along								24	S
		Cross								6	off
		Result								25	146
24	0100	Along								30	S
		Cross								6	off
		Result								31	149
24	0700	Along	122	S		102	S			37	S
		Cross	0		165	0		North	35	7	off
		Result	122	160		102	160			38	149
24	1300	Along								29	S
		Cross								6	off
		Result								30	148
24	1900	Along								23	S
		Cross								2	off
		Result								23	155
25	0100	Along								12	S
		Cross								1	off
		Result								12	155
25	0700	Along	21	S		41	S			6	N
		Cross	4	off	152	8	off	North	59	6	on
		Result	21	149		41	149			8	295
25	1300	Along								7	S
		Cross								3	off
		Result								8	137
25	1900	Along								8	N
		Cross								3	on
		Result								9	319

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Table 4: Current Data (Concluded)  
Nov 1988

Day	Time	Pier Measurements					Beach Measurements			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir	
		Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed			Dir
26	0100	Along								1	N
		Cross								1	off
		Result								1	25
26	0700	Along	11	N				23	N	14	N
		Cross	13	off	140	0				4	on
		Result	17	30		0	0			15	324
26	1300	Along								8	N
		Cross								1	off
		Result								8	347
26	1900	Along								3	N
		Cross								3	on
		Result								4	295
27	0100	Along								4	S
		Cross								2	on
		Result								4	187
27	0700	Along	38	N		47	N	12	N	20	N
		Cross	6	off	152	7	off			3	on
		Result	39	349		47	349			20	331
27	1300	Along								14	N
		Cross								2	on
		Result								14	332
27	1900	Along								16	N
		Cross								3	on
		Result								16	329
28	0100	Along								18	N
		Cross								2	on
		Result								18	334
28	0700	Along	32	N		55	N	76	N	20	N
		Cross	11	off	165	19	off			3	on
		Result	34	359		59	359			20	331
28	1300	Along								4	N
		Cross								3	on
		Result								5	303
28	1900	Along								6	S
		Cross								3	on
		Result								7	187
29	0100	Along								9	S
		Cross								1	off
		Result								9	154
29	0700	Along	13	S		32	S	91	S	5	S
		Cross	6	off	152	0				0	
		Result	15	136		32	160			5	160
29	1300	Along								3	S
		Cross								5	off
		Result								6	101
29	1900	Along								9	N
		Cross								1	on
		Result								9	334
30	0100	Along								10	N
		Cross								1	on
		Result								10	334
30	0700	Along	29	N		29	N	35	N	14	N
		Cross	4	off	165	3	off			3	on
		Result	29	349		29	346			14	328
30	1300	Along								9	N
		Cross								2	on
		Result								9	327
30	1900	Along								6	N
		Cross								1	on
		Result								6	331

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## PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Nov 1988

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0849	40		58	122	13.9	1.0236	1.2
2	0835	40			85	13.9	1.0234	1.2
3	0812	50		34	98	14.4	1.0242	1.2
4	0839	100		110	61	15.6	1.0250	0.9
5	0827	90		95	158	16.1	1.0250	0.9
6	0912	90			104	16.1	1.0256	0.9
7	0837	95			70	15.9	1.0254	0.9
8	0814	95		83	30	16.1	1.0268	0.9
9	0649	45		35	37	16.1	1.0258	0.9
10	0810	none	visible		12	15.6	1.0256	1.8
11	0817	25		27	110	15.7	1.0248	0.9
12	0906	50		30	110	14.5	1.0254	1.2
13	0814	70			134	14.5	1.0250	2.1
14	0821	60		40	85	15.0	1.0250	3.0
15	0829	80			85	15.0	1.0250	3.0
16	0831	80			85	15.0	1.0248	4.3
17	0826	95		115	79	16.1	1.0254	1.2
18	0833	50		34	146	14.5	1.0256	0.9
19	0904	60		34	110	14.5	1.0258	1.2
20	0920	80		110	116	15.0	1.0248	2.1
21	0713	15		24	24	15.0	1.0250	2.7
22	0819	40		43	98	13.9	1.0250	0.9
23	0853	40		12	110	13.6	1.0250	1.2
24	0922	20		31	171	12.2	1.0236	0.9
25	0906	50		30	122	12.2	1.0230	1.5
26	0934	100		95	24	13.9	1.0252	1.5
27	0901	90		110	12	14.5	1.0248	1.2
28	0835	100		99	116	15.0	1.0248	1.8
29	0830	10		25	30	12.2	1.0260	1.5
30	0812	80			73	13.4	1.0270	1.5

## PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

# FRF Tide Heights

Nov 1988

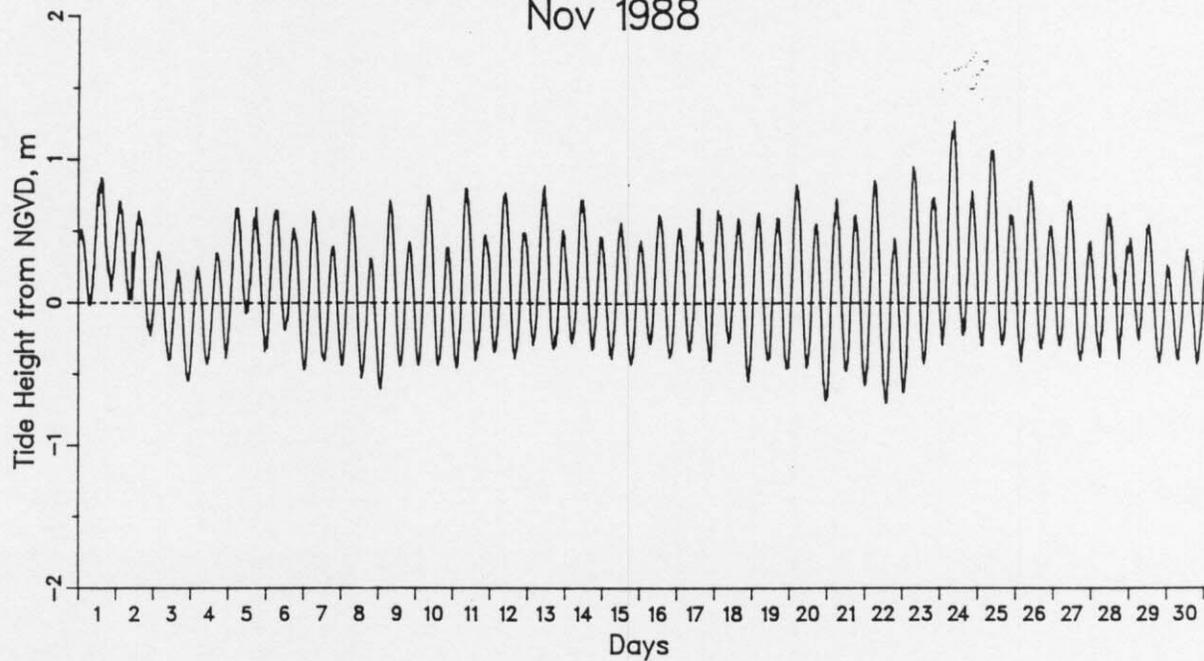


Figure 4. Water level time history

### Monthly Water Levels, m NGVD

Extreme Low = -0.70 on day 22 at 1230 hr  
Extreme High = 1.26 on day 24 at 812 hr  
Monthly Mean = 0.12  
Mean Low = -0.37  
Mean High = 0.70  
Mean Range = 1.07

Table 6: Water Levels,m NGVD

		Nov 1988			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	612	-0.02	0.80	0.33	0.82
1	1837	0.08	0.87	0.45	0.79
2	703	0.02	0.71	0.36	0.69
2	1928	-0.23	0.64	0.15	0.86
3	753	-0.40	0.36	-0.04	0.76
3	2018	-0.54	0.23	-0.16	0.78
4	843	-0.43	0.27	-0.07	0.69
4	2109	-0.38	0.58	0.06	0.96
5	934	-0.07	0.66	0.30	0.74
5	2159	-0.34	0.67	0.16	1.01
6	1024	-0.19	0.65	0.22	0.84
6	2249	-0.47	0.59	0.05	1.06
7	1115	-0.41	0.64	0.06	1.04
7	2340	-0.44	0.65	0.04	1.08
8	1205	-0.52	0.67	0.01	1.19
9	30	-0.60	0.71	-0.05	1.31
9	1255	-0.44	0.69	0.07	1.13
10	121	-0.43	0.75	0.09	1.18
10	1346	-0.43	0.74	0.07	1.17
11	211	-0.45	0.80	0.09	1.25
11	1436	-0.40	0.73	0.12	1.13
12	301	-0.34	0.77	0.16	1.11
12	1527	-0.39	0.73	0.11	1.12
13	352	-0.29	0.82	0.19	1.11
13	1617	-0.32	0.73	0.13	1.05
14	442	-0.28	0.72	0.17	1.00
14	1707	-0.33	0.69	0.13	1.01
15	532	-0.39	0.56	0.06	0.95
15	1758	-0.43	0.52	0.02	0.95
16	623	-0.28	0.62	0.12	0.90
16	1848	-0.38	0.59	0.09	0.96
17	713	-0.34	0.66	0.11	1.00
17	1938	-0.40	0.66	0.12	1.06
18	804	-0.28	0.61	0.18	0.89
18	2029	-0.55	0.60	0.03	1.14
19	854	-0.40	0.63	0.10	1.02
19	2119	-0.46	0.78	0.11	1.24
20	944	-0.45	0.82	0.14	1.28
20	2210	-0.68	0.63	-0.05	1.31
21	1035	-0.48	0.73	0.10	1.20
21	2300	-0.58	0.83	0.06	1.41
22	1125	-0.70	0.85	-0.01	1.55
22	2350	-0.62	0.95	0.01	1.57
23	1216	-0.42	0.94	0.22	1.37
24	41	-0.29	1.19	0.36	1.49
24	1306	-0.22	1.26	0.42	1.49
25	131	-0.30	1.06	0.29	1.36
25	1356	-0.29	1.06	0.30	1.36
26	222	-0.41	0.83	0.17	1.24
26	1447	-0.32	0.85	0.19	1.17
27	312	-0.30	0.70	0.17	1.00
27	1537	-0.40	0.72	0.08	1.11
28	402	-0.37	0.63	0.09	1.00
28	1628	-0.39	0.60	0.14	0.99
29	453	-0.25	0.53	0.13	0.78
29	1718	-0.41	0.55	0.00	0.96
30	543	-0.39	0.36	-0.04	0.75
30	1808	-0.42	0.37	-0.05	0.80

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in October and the two surveys in November on profile line 188, located 517 m south of the pier. As a result of the low wave conditions during the month, only minor changes occurred on the profile line. These included a small amount of erosion on the foreshore (80 to 120 m) and a 30-m shoreward shift in the nearshore bar (200 to 300 m).

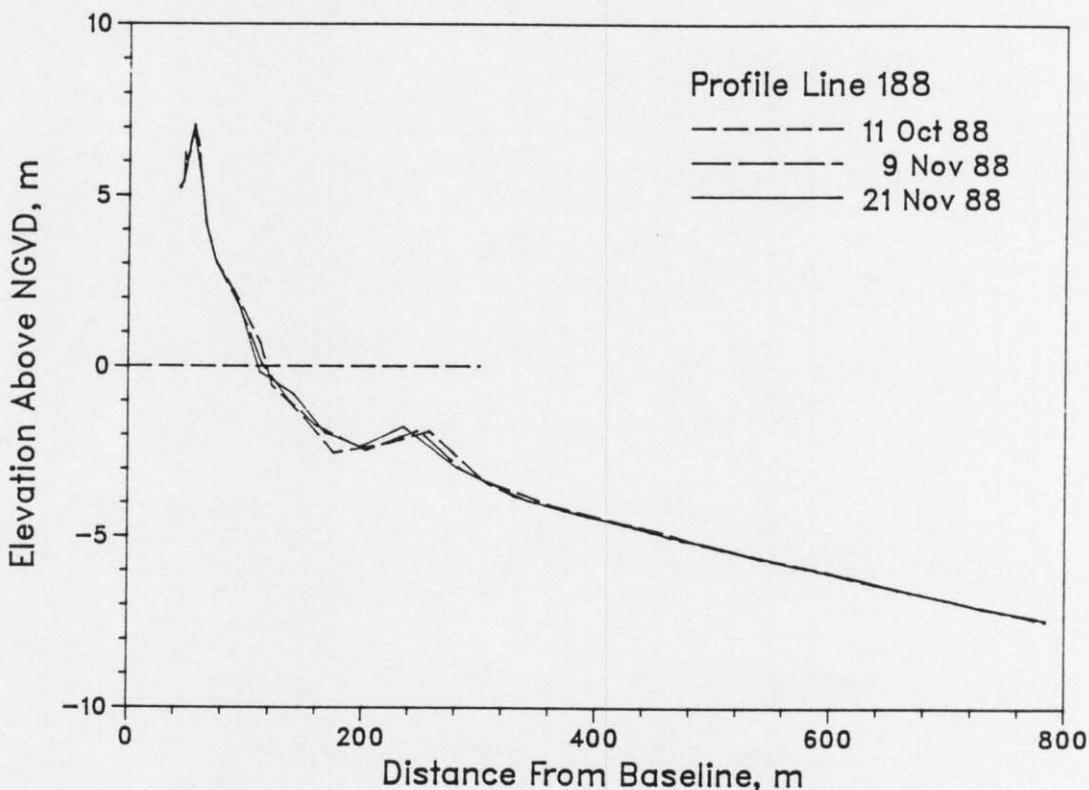


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1988. Two minor changes resulted from accretion at the toe of the foreshore (120 m) and movement of the nearshore bar (230 m).

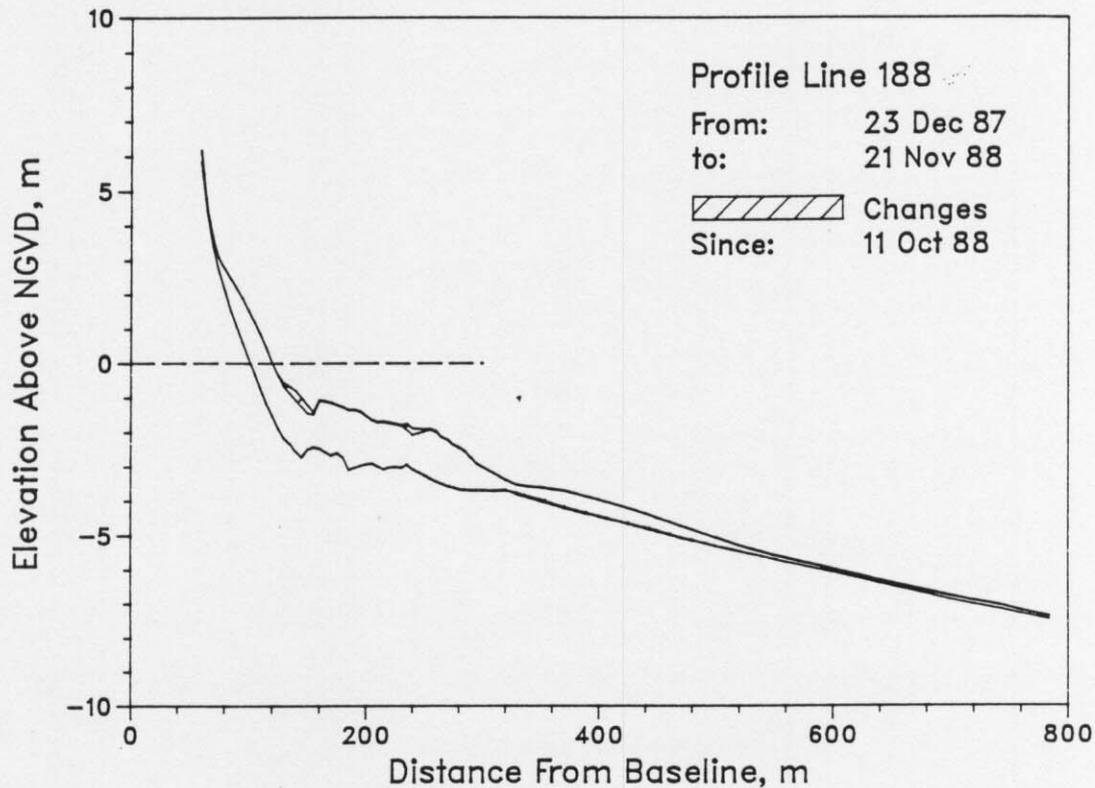


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey conducted on 19 December 88. Wide contour lines on the change diagram represent areas which eroded; thin lines indicate accretion.

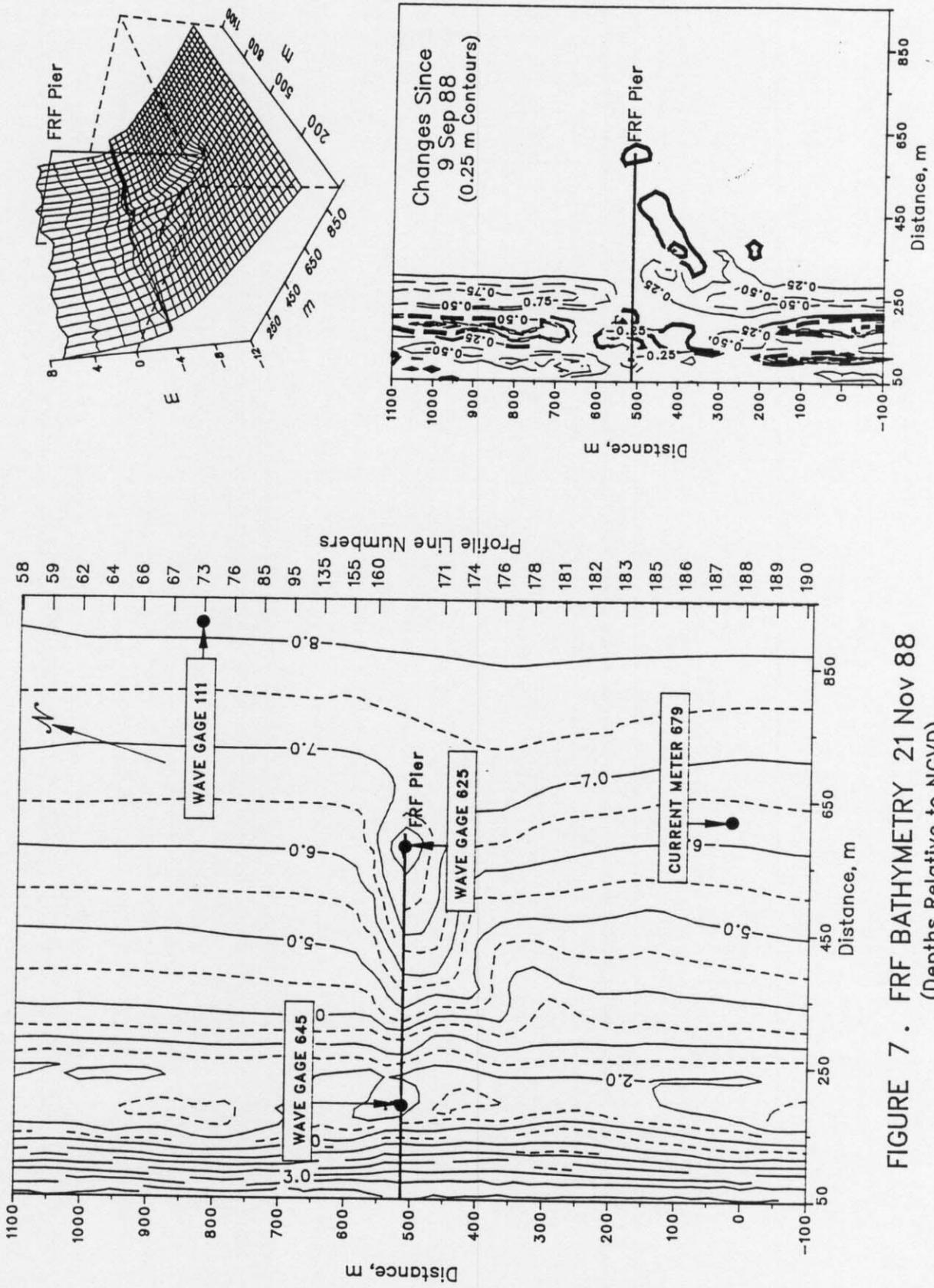


FIGURE 7 . FRF BATHYMETRY 21 Nov 88  
(Depths Relative to NGVD)

PART VIII: SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when wave heights exceeded 2 m at the seaward end of the pier. When this occurred, four contiguous 34-min wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
1 Nov (1300)	1 Nov (1634)
24 Nov (0208)	24 Nov (1708)

B. Storm Synopsis.

1 November - Forming off the Georgia coast early on 1 November, this storm moved rapidly past the FRF and was located off New England by the next day. Maximum onshore winds (from northeast) peaked near 11 m/s at 0208 hr on 1 November. At 1442 EST the maximum  $H_{mo}$  (Gage 625) of 2.41 m ( $T_p = 6.92$  sec) was recorded, and at 1600 EST the minimum atmospheric pressure of 1003.3 mb was recorded. Total precipitation was 30 mm.

24 November - Forming in the Gulf of Mexico, Tropical Storm Keith slowly followed a cold front across Florida on 22-23 November and continued to move to the northeast into the Atlantic on 24 November. The combination of a strong Canadian high pressure system and this offshore tropical storm produced storm waves on the 24th. Maximum onshore winds (from the north-northeast) reached 14 m/s at 0208 EST on the 24th followed shortly (0400 EST) by the minimum atmospheric pressure of 1010.1 mb. The maximum  $H_{mo}$  (Gage 111) of 2.47 m ( $T_p = 7.30$  sec) was recorded at 1600 EST. There was no precipitation.

## Distribution List

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BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
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